Chapter III
THE HUMAN TELEGRAPH

WHAT do we ordinary folk know about the electric current and its use in the telegraphic system? We know that the current or force is generated in dynamos or batteries; that it can be collected and stored; that it travels along conducting wires to various points, carrying messages for us. We know that these conducting wires are bound up in cables or travel through tubes, and that in these cables and tubes each wire is 'insulated' or separated from the rest by a coating of non-conducting material, so that no message may go astray. We know that a large cable or set of telegraph wires divides up into smaller sets, each wire eventually finding its way to an office, where it delivers messages and receives others—messages travelling both ways.

53. But though we know what the electric current can do for us, though we have learnt how to create the conditions under which it shall come into being, and have made it our servant in a thousand ways, we do not really know what it *is*. All that we know is that in the cells of the battery *something happens* which liberates from certain substances a mysterious force, for which man is every day finding new uses. We know that this force, or current, is liberated either by mechanical action or by chemical action, i.e. by the action of a certain liquid on certain metals, as in the little battery that supplies our household electric bells. This latter instance I want you to keep in mind.

54. So much for the familiar yet mysterious current itself. Now as to its uses in the postal telegraph department. We know that there is a great central office in London—how great it is few of us have any conception—with supreme control over the whole system, and responsibility for every new regulation or development of the system; and that there are district offices, each attending to the business of its own circuit, the central office not interfering unless something goes wrong or something new has to be introduced. If Manchester wants to communicate with Liverpool the message does not come to London and out again, but travels directly from point to point over its own wire. But if any difficulty should arise in the transmission from Manchester to Liverpool it may have to be reported to the central office.

55. Now we must remember that this gigantic system did not burst upon us in full working order as we know it to-day, but has been a growth and a development. A little while ago (the telegraph was only born in the thirties) we can imagine the central direction a very one-man affair, every step being experimental, every little detail requiring the attention of the directing head. We can imagine, too, how details would get into working order, would grow into 'regulations,' would be handed over to a staff of assistants, and could be dismissed from the controlling mind, leaving it free to contemplate new possibilities and initiate fresh departures. Thus there would be, and has been, not only a growth of the system as a whole, but an internal development: the spring-

ing up of new departments, each gradually handed over to its own management. And yet the central office, while thus constantly relieving itself of the burden of detail, may at any moment become conscious of what is happening at the smallest, remotest village telegraph-office in the kingdom.

56. The resemblance between this modern outcome of man's inventiveness and the human telegraph, which has been in existence as long as man himself, is very striking, and a comparison of some of the details in which they correspond is interesting.

57. The nervous system is also worked by a mysterious current, generated and stored in nerve-*cells* and carried along nerve-*fibres*. The nerve-cells are found in masses called *ganglia*, and exist chiefly in the cavities of the skull and of the spinal column. They are centres of nerve-*impulse*, and correspond to the electric battery. The brain and spinal cord, taken together, are the central organ of the nervous system. From these issue the nerve-fibres, the tiny telegraph wires along which the current is conducted, carrying messages to and fro.

58. But while in the postal telegraph system messages travel along a wire in either direction, the human system provides two sets of fibres, one set to carry messages *in*, and another set to carry messages *out*, the one set being called the *afferent*, *in-carrying*, or *sensory* nerves, and the other the *efferent*, *out-carrying*, or *motor* nerves.

59. In this wonderful system the brain is, very literally, the head office. From it issues every

definite order, and to it is referred every matter requiring attention, deliberation, and decision; but a good deal of business, when it is, so to speak, in 'going order,' is handed over to other centres, which we may liken to district offices; and these district offices, or lower nerve-centres, are in the spinal cord. The brain is thus relieved of a good deal of detail, but it keeps the ultimate control, and may at any moment become conscious of what is happening at the remotest part of the body, that kingdom over which it rules.

60. For instance, to you and me the action of walking is perfectly automatic; we are not obliged to *attend* to it. While we are walking our minds are full of a thousand things which have nothing to do with locomotion. But should a pebble get into the boot, and walking become limping, we become conscious of the accident. The news of the pebble has been flashed to the head office, and from the head office messages have been flashed to certain muscles, and the back bends, and the hands unlace the boot, shake out the pebble and lace the boot up again. We shall come back to this illustration later on.

61. We shall get a clearer idea of these processes if we look more closely at the central organ itself, which consists, as we said, of the brain or higher centre, and the spinal cord or lower centre.

62. The spinal cord runs down from the brain through the spinal column, which is, as you know, a series of bones (vertebrae) connected together by strong cartilages. The cord itself may be roughly described as a column of *grey* matter

enclosed in a column of *white* matter, the whole in an envelope composed of tissue containing a great number of blood-vessels. The grey matter is a continuous mass of nerve-*cells* (ganglia), and the white matter is a column of nerve-*fibres* arranged longitudinally round it. You remember that we said such masses of nerve-cells were centres of nerve-impulse, and we compared them to the electric battery; so that the spinal cord is practically one long generating battery with a constant supply of the liquid necessary to keep it active, and lying in the middle of a cable of innumerable conducting wires.

63. So, just as we have in the electric telegraph two parts, one which generates the current and one which conducts it, so we have in the human system two parts, the cell, in which the current is generated, and the fibre which conducts it. And there is even that curious correspondence between the necessary supply of liquid to the electric battery—you know how, when our bells refuse to ring, we say 'the battery has gone dry,' and we fill up the cells with water—and the necessary supply of blood to the nerve-cells throughout the body.

64. Bundles of nerve-fibres are given off from the cord at regular distances. These leave the spinal column in pairs through openings between the vertebræ. They are bound up in trunks, or nerve-*cases*; and, like the wires in a cable, every fibre in a nerve-trunk is insulated by means of a non-conducting material, and kept apart from its neighbours during the whole of its course. For the nerves do not form a 'network,' as we are apt

to think. They travel side by side in one general direction; and (as in the telegraph system) the larger trunks or cables divide into branches, and these divide again, until each little fibre reaches its destination in a muscle-cell, a skin-cell, or a blood-vessel. Some of them, at their extreme ends, are split up into more minute fibres, but the more important continue undivided to the end, and terminate in a little *pad*, or *bud*, or *end-organ*, all these names being given to them. In most of the nerve-trunks afferent and efferent fibres are bound up together, but being insulated they do not interfere with each other.

65. 'Each in-carrying nerve is played upon and excited to its inward activity by a particular force of the outer world. Usually it is insensible to other forces.'—(*James.*) That is to say, the optic nerve is insensible to air-waves, which give us sensations of sound; and the auditory nerve takes no notice of ether-waves, which give us sensations of light. The nerves of touch cannot smell, nor can we distinguish heat or cold through hearing. Yet the structure of all the nerve-fibres is alike, and the current which travels along them is the same. The difference is in the end-organs of these in-carrying nerves. Professor James says:—

'Just as we arm ourselves with a spoon to pick up soup, and with a fork to pick up meat, so our nerve-fibres arm themselves with one set of end-apparatus to pick up air-waves, with another to pick up ether-waves.'

In his picturesque way he compares these end-organs to little telephones—

'into which the material world speaks, and each of which takes up but a portion of what it says. The brain-cells

at the fibres' central (inner) end are as many others, at which the mind listens to the far-off call.'

66. The upper part of the spinal cord, when it enters the skull, broadens out, and is there called the *Medulla Oblongata*. This continuation of the cord has the same general structure, the grey matter inside, the white outside, but the mingling of the two is more complicated and there is a greater quantity of grey matter.

67. 'The medulla is a very important organ, for all the nerves pass through it and every impulse that travels to or from the brain. Any injury to the medulla brings serious consequences.'—*Huxley*.

68. At the base of the skull, in front of the medulla and including a part of it, there is a collection of ganglionic masses which are called the Sensory Ganglia, or, taking them together, the Sensorium.* Here the nerves of special sense (smell, sight, hearing, etc.) have their inner terminations, and this is the department where incoming messages from the special sense-organs, travelling through the afferent nerves, are received and are answered by outgoing messages through the motor nerves. We might call it the Central Telegraph Department.

69. As an illustration:—Your hand accidentally touches the hot tea-kettle: you feel a burn and

* The nerves of Touch extend all over the surface of the body, and are sometimes called the nerves of Common Sensation. It is perhaps for this reason that some writers refer to the whole body as the Sensorium. Carpenter, however, is very definite in applying this term only to that 'assemblage of ganglionic masses *lying along the base of the skull* in man, in which the nerves of the special senses, Taste, Hearing, Sight and Smell, have their central terminations.'

snatch the hand away. The whole thing is what we describe as instantaneous, and yet what happened between the touching and the snatching away takes some time to tell.

(*a*) A stimulus was received by the little nerve-end in the skin—a sense-impression.

(*b*) Along those in-carrying nerves the news of that impression was flashed to the central office.

(*c*) On reaching the sensorium the *impression* became a *sensation* and then you felt, or became conscious of, the burn. (That is what I meant when I said that it was not the skin that felt the burn, but the brain.)

(*d*) Back through the motor nerves flashed a message to the muscles, bidding them contract and pull the hand away.

70. Now this is a simple reflex action. Thought and will were not concerned. The message was taken and answered by the lower brain. The same reaction to a stimulus would have occurred, in exactly the same way, had you been a frog, or a fish, or a centipede; for down through the descending types of the animal kingdom for a long way we find just the same *kind* of nervous system that we ourselves possess, so far as our description has taken us. In some of the lowest forms of the animal creation a solitary ganglion and a few nerve-fibres suffice for the needs of the little life. As we ascend the scale we find a gradual addition of new organs, needing new muscles to move them, and these again needing new nerves and new ganglia; till, with the development of

eyes and other organs of special sense, these sensory ganglia appear which we have grouped together and called the sensorium. So far as our animal and organic life is concerned it is much the same as that of the lower creation. The human telegraphic system, like that of the post office, has been a growth and a development; but it has taken millions of years.

71. We have now to speak of a further step in that development. There is an inner as well as an outer life. Thought, feeling, memory, reasoning, judgment—where are they? The seat of all these processes is that mass of matter which fills the skull above the sensory ganglia; the cerebrum, or upper brain.

·72. The structure of the brain is complicated, and has been called the *Pons Asinorum* of physiology, but fortunately a few facts are all that we need to know about it, and these are interesting.

73. In the cerebrum the arrangement of white and grey matter is just the opposite of what it is in the spinal cord. There the grey matter (the battery) lies in the middle, and the white (conducting fibres) massed round it. In the cerebrum the grey matter is outside, forming a kind of rind, called the *Cortex*, and beneath that is a great mass of nerve-fibres, crossing and recrossing each other. The cerebrum is divided into two hemispheres, left and right, united by a band of white matter at the bottom of the dividing cleft. In fact, its shape is very like the kernel of a walnut. If you wish to give a child an idea of the shape of this

useful part of his anatomy, take a walnut out of its shell and divide it. The dark skin, covering all its convolutions, may stand for the grey matter of the cortex, except that the brain-rind is much thicker in proportion, and there are many more convolutions. If you want to see it yourself, buy a sheep's head and ask the butcher to split it open without injuring the brain (if he can) and take the brain out for you. The best way is to saw it round and then across the top, but not to let the saw go quite through, and then split the parts off with a chisel and hammer. When the skull bone has been safely removed there will still be a covering to take away, a tough sort of membrane, which can be slit round the edges and removed. Then you will see the brain with all its convolutions, and notice how the cortex is covered with another membrane which keeps it supplied with blood, dipping down into all the convolutions. This is probably as far as you will want to go (!), but if you investigate further you will find that the 'grey' matter is not really grey, but rather a reddish brown, and soft, 'something between jelly and porridge,' and the white part stringy.

74. We have spoken more than once about the importance of a blood-supply to the nerve-cells; and one thing which gives us an idea of the expenditure of power during mental activity is the fact that 'though the brain of man has not ordinarily more than *one-fortieth* of the weight of the whole body, yet it is estimated to receive from *one-sixth* to *one-fifth* of the whole circulating

blood.'—(*Carpenter.*) And the blood supply must not only be sufficient in quantity but good in quality. The nourishing parts of the blood go to keep the cells in repair, and the oxygen which it carries is the chief agent in the production of the current. When we feel stupid and faint in an overcrowded room, it is because heart and brain are being starved of oxygen. These facts have a meaning for the teacher (32).

75. The cells of which this grey matter consists serve not only to generate the current but to switch it on. By the energy generated in the cells the in-coming (sensory) currents are changed to out-going (motor) currents, and the motor currents are switched from one fibre to another.

76. When a current of neural energy passes through the cortex it leaves a kind of 'path' behind. The nature of the paths is not known, but it is known that every time a path is travelled by a current it makes it easier for the next current to travel that way. Now, this is the physical part of the formation of Habit and of Memory. When you play a passage for the first time you have to think about it. The head office is attending to it. The eye sends in from the page a certain message through the in-carrying nerves; it passes through the grey matter of the brain and is switched on to some out-carrying nerves which cause certain muscles of your arms and hands to make the movements necessary to the playing of the passage. This nerve-process leaves a path in the actual matter of the brain. Every time you repeat the passage the path becomes deeper and more definite

and the transit of the message is *more rapid.* After a while it does not go to the upper brain at all, but is switched off at another point, outside consciousness, at one of the lower centres. When that happens, *Habit has taken charge of the mere mechanism*, leaving your mind free to attend to the meaning and interpretation of the passage.

77. The grey matter of the brain is constantly being used up by the discharge of neural energy needed for all our doings and thinkings (34), and as constantly renewed; and the curious thing is that though the tissue in which a neural path has originally been formed disappears in time, the renewal is so gradual, and the new cells fit so exactly into the place of the old, that not only is the organic structure of the individual brain maintained, but these neural paths are reproduced and perpetuated. As a scar remains upon the body though its tissues wear out and are renewed many times, so a memory or a habit will persist, because though the 'paths' on which the memory or the habit depend wear out gradually, they are as gradually renewed.

78. Now of what practical use is all this to a music teacher? We talk about muscular control in pianoforte-playing, but can we really control any muscle or group of muscles and make them obey our will? I don't think we can *directly* control our muscles. What we really do is to will a *result.* To go back to the illustration of the pebble in the boot. We do not *will* that some muscles in the back shall contract and others relax, so that the back shall bend; or those of the hand combine

to unlace the boot. The only thing we *think* about is getting rid of the pebble; our nervous system does all the rest for us automatically. If I want to take a book down from a shelf, I do not have to think about the co-ordination of all the muscles needed for the stretching and grasping and holding. I only think of my object, and the process of attaining it is done for me. It is something like driving a motor car. The driver of the car does not directly control the action of each little separate part of the engine, but by his control of the driving wheel he decides the direction of the car. A gentle pressure to right or left, and the engine does the rest. The *Will* is our driving wheel; it 'commands the automatic power of the brain,' and the machinery of the nervous system obeys.

79. To come to our own subject, music:

'No better illustration could be adduced than that which is furnished by vocalization. The co-ordination of a large number of muscular movements is required: and so complex are their combinations that the professed anatomist would be unable, without careful study, to determine what is the precise state of each of the muscles concerned on the production of a musical note. Yet we simply *conceive* the tone we wish to utter, and say to our automatic self "do this"; and the well-trained automaton does it.'—*Carpenter.*

If we had to think about controlling all the muscles brought into play in walking, we should never walk; and though it may be quite right and useful for the *teacher* of singing to know all about the vocal ligaments and thyroid and cricoid and other cartilages and the work they do, in my humble opinion the less the young pupil knows about them the better. Let him *listen to a beautiful tone*

and try to imitate it. So far as he succeeds, his vocal apparatus is getting into working order. It is all a matter of *listening, with an ideal before the mind.* The gradual co-ordination of the muscles, through practice, is automatic.

80. And in learning the make-up of pianoforte technique, what do we do? We can *will*, separately, certain movements or non-movements: rotary movement, lateral movement, arm-weight, arm-support, arm-balance, and so forth. Each movement is simple, and the muscular adjustment needed for it is already established; but a farther and more complex adjustment is needed when several of these are used in combination.

81. How does this complex adjustment come about? The cerebrum is apparently a higher nervous system controlling the lower, combining and co-ordinatng simple elementary movements into the complex movements needed for certain kinds of activities that have to be *learnt*, such as throwing a cricket ball, riding a bicycle, or playing an instrument. The elemental movements needed in pianoforte-playing are already provided for by the lower nervous system, and we use them unconsciously all day long. When a woman is sewing she uses most delicate rotary movement; give her a duster and the movement is lateral. For some purposes the muscles are tense, for others they are relaxed, and so on. These simple movements and conditions are habitual. But new conditions and new purposes necessitate new combinations and fresh adjustments, and then—the head office, the upper brain, steps in, takes the

matter in hand, and gradually gets this new department of activity into going order. After that it is a matter of listening, or, rather, of *prehearing*, i.e. imagining the effect of what we are about to play. We may not at once achieve that which we mentally hear, but gradually the automatic co-ordination will occur in answer to the musical thought, and we can forget that we have any muscles at all. An American writer says:

'Muscular ability depends not so much upon the degree of development of muscles as upon the harmonious working of all the muscles concerned in a movement. It is therefore more a matter of nervous connections than of muscular strength. This is perhaps best illustrated in throwing and wrestling, where victory goes not to the strongest but to the one whose muscles work together to the best advantage. A skilful thrower uses first the muscles of the legs, then successively those of the body, shoulder, arm, forearm, wrist, and fingers; and the ball, shot, or hammer leaves his hand with a force equal to the sum of the forces exerted by these muscles. An unskilled thrower, on the other hand, uses principally the muscles of the shoulder and upper arm, and these not in harmony; hence, though he have the arm of a blacksmith, he may be beaten by a stripling baseball player.'—*Kirkpatrick.*

And we know how the small, slightly-built Japanese wrestler, with his *ju-jitsu* training, throws a large and heavy man with ease.

82. In pianoforte-playing, too, tone-production and finger dexterity depend less on actual development of the muscles than on their harmonious working and on the elimination of all unnecessary movements. A large biceps is not necessary for producing chords that are full and rich in *quality*,

though a heavier limb may increase the tone-*quantity*; and though from an artistic point of view all unnecessary body-movements should be avoided, yet in pianoforte-playing, as in ball-pitching, the whole body is involved. A firm seat is as necessary to the pianist as to the rider; and because children's pieces are usually limited in range to the middle of the keyboard, exercises should be invented to give freedom of movement. Thus the very early interval exercises ('Teacher's Guide,' page 47) can be played all over the key-board, as far up and down as the child can reach without toppling over, so that he learns early to keep a firm seat. Chord exercises, too, can be utilized in this way.

83. In early pianoforte-training another important fact has to be considered. The large muscle-groups—those of the whole arm—begin to work harmoniously before the finer ones of the fingers are under control. As soon as this fact was grasped by educationists those occupations which needed delicate finger adjustments, such as needle-threading, 'Froebel' drawing, etc., were banished from our infant schools and kindergärten, and there were great modifications in the teaching of writing.* 'The true rule with little children is to begin with large movements in every activity and pass gradually from them to smaller ones.' In view of all this do we not, when we begin pianoforte-training with five-finger exercises, begin (literally) at the wrong end?

* The one good thing that I could discern in Dr. Montessori's apparatus was that for teaching writing, beginning with letters so large that the whole arm has to be used in the process.

84. It is noteworthy that Tobias Matthay starts the child with arm movements, and the finger-differentiation needed for five-finger exercises is not attempted until several of the important arm conditions and movements are fairly well established.

85. If we could postpone the practice of five-finger exercises until the need for them can be understood by the pupil—namely, their use in training for endurance—it would be a great gain every way. Technically, because we should avoid the premature fatigue of those delicate muscles that often results in weakness; and musically, because I believe that there is nothing more deadening to a child's musical feeling than the dreary repetition of a foolish little group of notes which he cannot think of as music. Really intelligent and attentive practice of such exercises is only possible to the pupil who is of an age to appreciate their final value.*

86. The addition of the cerebrum to the nervous system was its crowning. It first appears in vertebrate animals as a very rudimentary organ, and in proportion to its development they show signs of what we call 'intelligence.' In the higher types we recognize a behaviour that can only be due to an elementary power of reasoning; and dogs give unmistakable signs of feeling. But from

* If the Primary and Elementary divisions of the Associated Board Examinations were exempted from Aloys Schmidt, or these exercises made optional, and examiners judged the children's technical ability by their playing of the pieces and studies, I do not think we should lose anything, and might gain a great deal. The experiment might be worth trying for a couple of years.

animal intelligence to human intelligence is a far cry, and so is the difference between the animal brain and the brain of man in its proportionate size and in its enormous development.

87. It may interest you to know that the male brain is usually about four or five ounces heavier than the female. You may draw what inference you like from that! But I don't think that the size of the brain (within limits) need affect its efficiency, because there may be a greater number of convolutions in the smaller skull-space; but it might affect the *kind* of mental output we get from the individual. So far as my own observation goes, the smaller brain is the quick brain. Its owner 'sees a point' quickly and is apt to trip you up in an argument; reads rapidly and takes in what he reads. But he is usually impulsive, and his judgment is not so reliable as that of the man of larger brain, who thinks more slowly and weighs things more carefully. One's own experience, however, is not sufficient basis for any theory, and I have no statistics on the subject.

88. All our sense-organs have not equal importance as gateways of knowledge. Touch is really the foundation sense, though sight and hearing are oftener placed at the top of the list. Think what a number of primary ideas the little child gets through his skin and muscles. By touching, handling, pushing, he learns about smoothness and roughness, hardness and softness, shape, size, weight, space, movement, distance, direction; as well as heat, cold, and pain. When people tell little children 'not to touch' things,

they do not realize that they are barring the door against ideas that are necessary to the child's mental growth. We need not give them our best china to play with, but they should be amply provided with objects that can be *handled*. Even the inevitable breakages and accidents are educational. Dolls and other toys give their little lives in a good cause; and baby's experiences in discovering that chairs and tables have sharp corners, that floors are hard when they fly up at you, that soap is not good to eat nor a hot teapot a pleasant plaything—all these go to make him, if for the moment a sadder, permanently a wiser baby. It is all part of his education.

89. Gradually the child becomes less dependent upon actual touch for the realization of the qualities of the things in the outer world. One sense reminds him of what another sense taught him.

'The world as we see it is built up on the framework of the world as we have handled it with our hands.'—*Magnusson.*

90. In connection with certain callings the senses may, and do, change their relative values. To the chemist, and in connection with the wine and tea trades, taste and smell—the mere 'protective' senses—are more important than hearing; while to one who is studying music hearing has even a higher value than sight.

91. That each sense organ should be perfect is, of course, important; but however perfect the organ, it must have material on which to exercise itself. The average nursery is well provided with objects for the education of hand and eye, but

what about the ear? Parents do not realize that here also the principle holds good that 'it is not sufficient that a human being have good sense organs; the objects on which to exercise them must also be present.' The ear, in the nursery, finds exercise in discriminating between varieties of *noises*; but noise is not sufficient for its education.

92. Do we realize that into many a nursery musical sounds never enter; that there is no material for the development of that mysterious sense which is hearing and so much more?

93. Suppose the nursery were kept bare of all but the necessary things; that there were no toys, no pictures, no dolls and teddy-bears and woolly lambs to take to bed and cuddle and talk to. The mind of the seven-year-old child would be a poor thing for the school teacher to begin upon. Points of contact would be difficult to find, and the observing powers would be weak for lack of exercise. That is exactly the difficulty that faces the music-teacher whose little pupil has had nothing musical to listen to, no baby songs stored up.

94. Happy the little one whose nurse sings to him, whose mother plays to him. Happy his future music teacher. But we know that in thousands of otherwise cultured homes little children live without any musical experiences, and come into the teacher's hands unable to imitate a sound and not knowing one tune from another. And the higher we ascend the social scale and the ladder of wealth the less do the children come in contact with music.

95. The value of the gateways of knowledge

depends on what the mind does with the knowledge when it comes inside the gate. Observation means more than mere seeing and hearing. It means attending, comparing, judging, and even doing. We do not train a sense for its own sake, but as a servant of the mind. The acuteness of a sense does not guarantee that the sense will be a good servant of the mind. A person may have excellent sight and hearing and be intensely stupid, deficient in observation and in power of reasoning about what he sees and hears. All that we can say is that the more perfect the senses the richer *may* be the content of the mind; but it does not follow that it will be so. The sense of hearing may be keen, but the mind behind the ear may be unable to compare musical sounds and to discriminate. Ear-training means the training of that power of discrimination.

96. Nowadays we talk of aural culture instead of ear-training, the reason advanced being 'lest it should be thought that ear-training meant the training of the outer lobe of the ear!' Now I cannot for the life of me imagine any one making that mistake but a born fool—or a South Sea islander, to whom, no doubt, a well developed lobe is an object of ambition, seeing that (for lack of pockets) he carries so many of his possessions hooked on to it or into it. Every intelligent person *knows* what is meant by ear-training. I am not quarrelling with 'aural culture.' It is a very good term—it looks prettier on a prospectus, and has the advantage of being rather vague—but it is only ear-training Latinized, and means just the

same thing, and nothing new. Whatever kind of sense-knowledge we use in the teaching of any subject, the object of the teaching is *mental* training and development, and the sense organ is only a door through which the knowledge enters. The most foolish of us knows that.

97. You see now how dependent we are upon our sense organs for all *direct* knowledge of things; and as we go on you will see more clearly that 'there is nothing in the mind'—not even the indirect knowledge that comes to us from books—'which was not first in the senses.'

98. We have examined the machinery which connects the outer with the inner world; we have talked about 'messages' and 'replies,' for which the technical terms are 'stimulation' and 'reaction,' and up to a certain point we have followed the course of the message which the end-organ picks up. But at a certain point our knowledge stops. We come to a blank wall. On either side of it we can investigate and experiment to our heart's content, but *through it* we never penetrate. Up to a certain point we see, then comes a blind spot, after which we see again. On one side of the wall, the side we have been talking about, lies physiology, on the other psychology; do not confuse the two. The physiologist and the psychologist work in adjacent fields and on parallel lines, but parallel lines do not meet, and no line of *explanation* has ever been drawn between them. Carpenter points out that 'no physicist attempts to *explain* how it is that electricity is generated by chemical change, but he knows that such a relation of cause and

effect exists between the two orders of phenomena, and that every chemical change is accompanied by a disturbance of electricity.' On this knowledge *he acts*, with what wonderful results we know; and if we teachers simply accept the fact of the correspondence between mind and brain, and act upon it, we can afford also to accept its mystery.